(12) UK Patent Application (19) GB (11) 2 131 502 A

(21) Application No 8235102
(22) Date of filing 9 Dec 1982
(43) Application published 20 Jun 1984
(51) INT CL³ F16D 7/00
(52) Domestic classification F2C 1B2B 1B3D1 1B5B 1B8 U1S 1637 F2C
(56) Documents cited GB 0683792 GB 0643528
(58) Field of search F2C
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(54) Switching off power in a torque sensitive clutch in a power tool

(57) The torque sensitive clutch comprises a driving clutch member (10) and a driven clutch member (12) rotatable relative to one another when the torque transmitted across the clutch exceeds a predetermined value. A timing ring (48) has in one end two inclined grooves (50, 52) in which are located opposite ends of a transverse pin (54). The timing ring is rotatable with the driving clutch member but is axially movable relative thereto. When the timing ring rotates in one direction the ends of the transverse pin are located in the shallower ends of the grooves (50, 52) and when the torque exceeds said predetermined value the timing ring is moved axially away from the driven clutch member, the pin (54) trips a latch mechanism (62) gripping push rod (60) and the push rod moves under spring or fluid pressure to switch off the motor. When the timing ring rotates in the other direction the ends of the pin are located in the deeper ends of the grooves and the pin will not trip the latch mechanism regardless of the torque. Hence, the motor will only switch off when rotating in one direction.

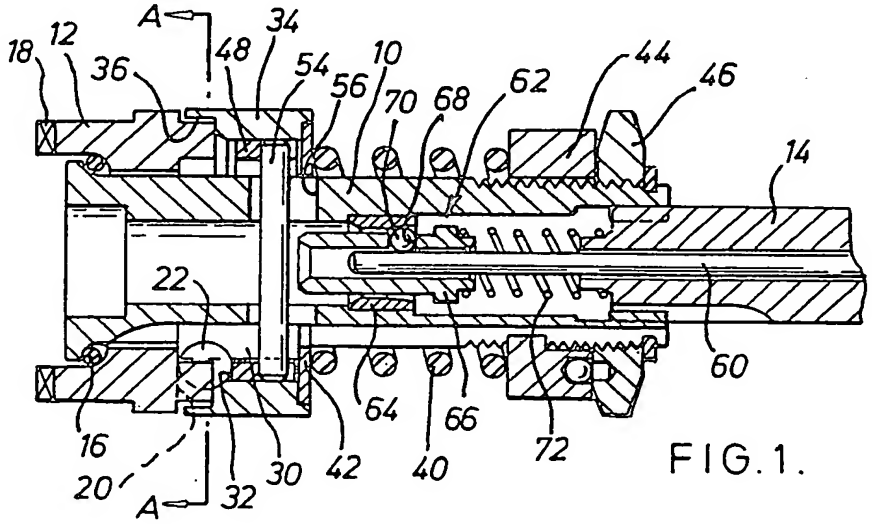

FIG.1.

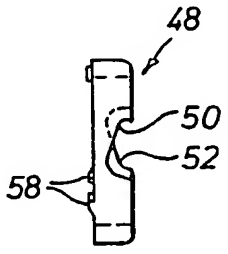

FIG.5.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

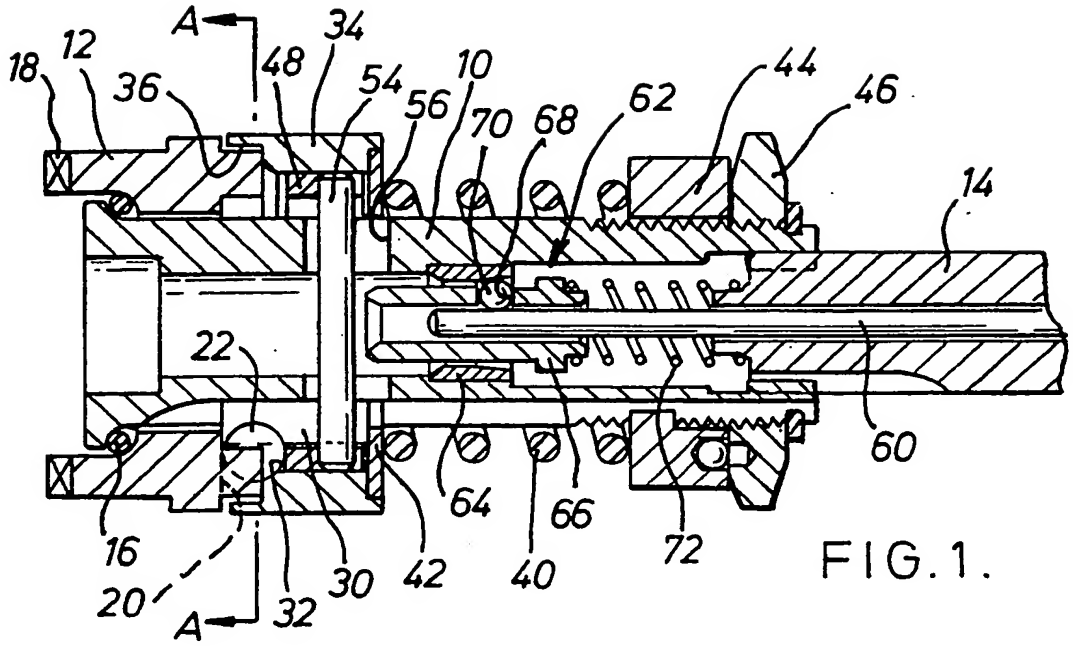
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FIG. 1.

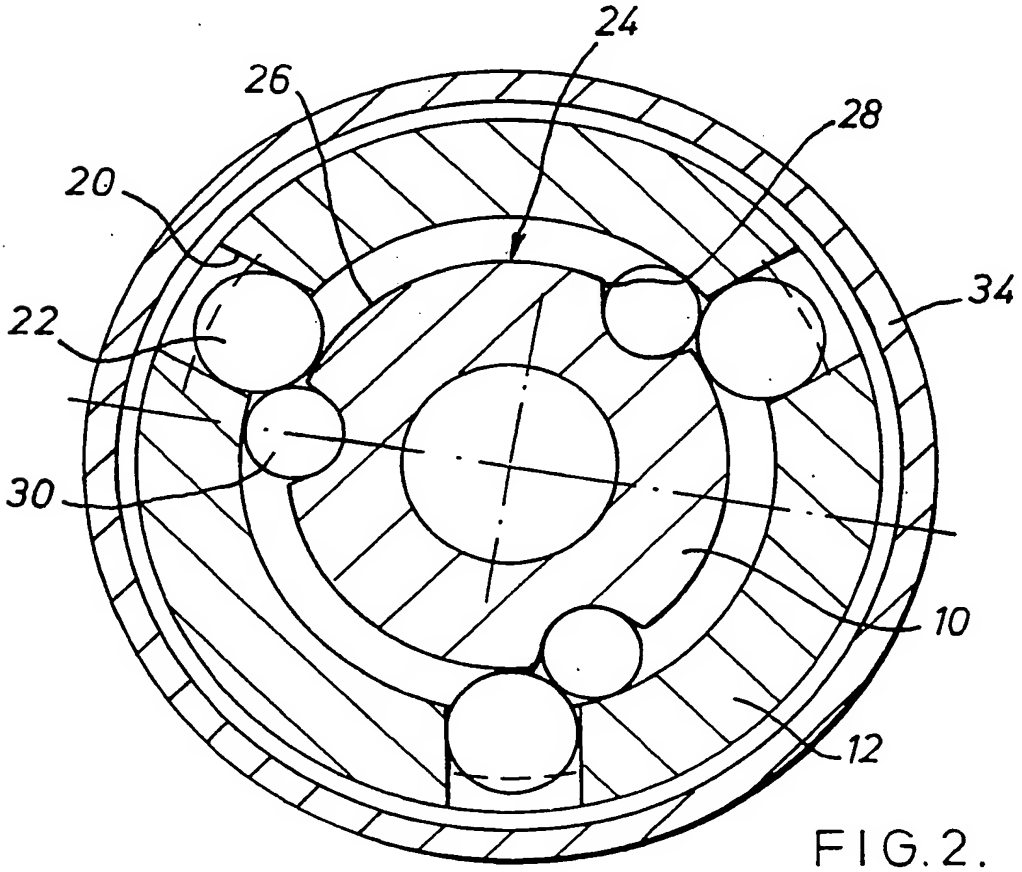
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FIG. 2.

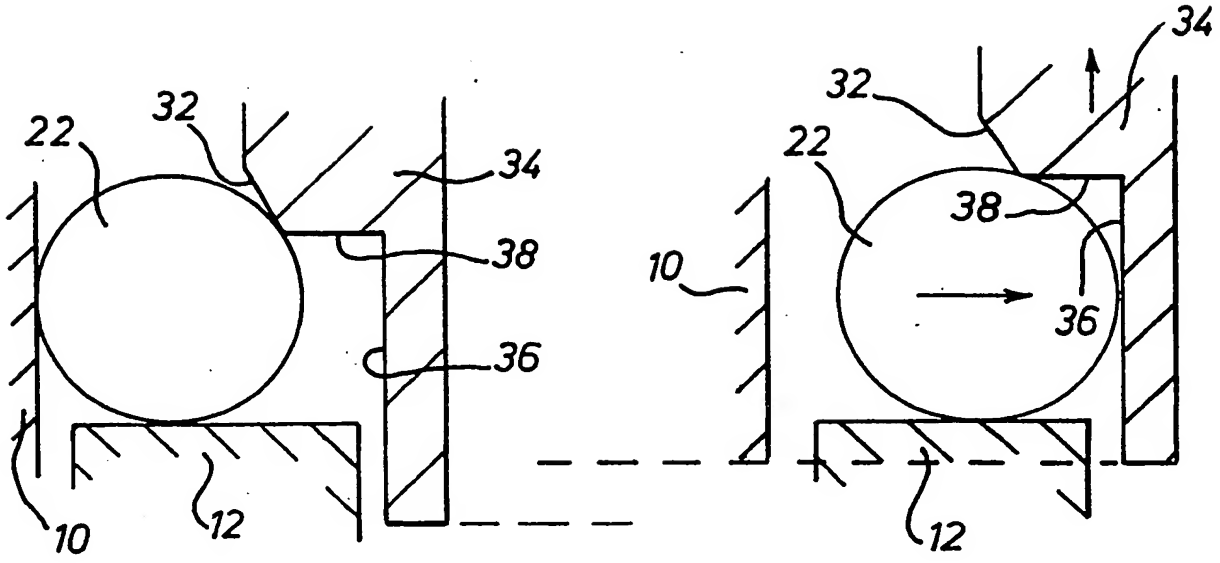

FIG. 3.

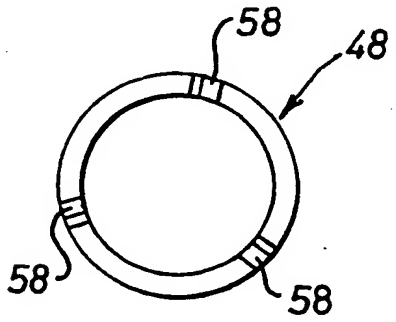

FIG. 4.

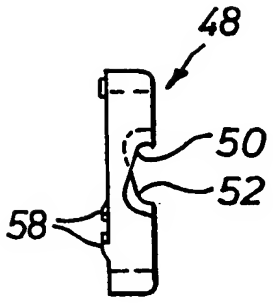

FIG. 5.

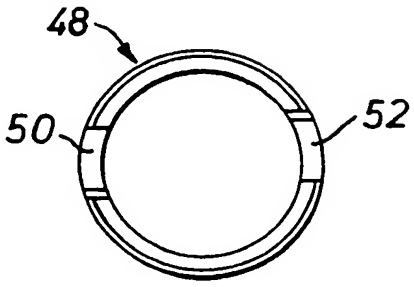

FIG. 6.

SPECIFICATION
A power tool

This invention relates to a power tool having a torque sensitive clutch.

It is known to provide a power tool with a torque sensitive clutch and an arrangement whereby the motor of the power tool is switched 'off' when the torque transmitted across the clutch exceeds a predetermined value. It is also known in such a tool to arrange that the value of torque at which the clutch 'breaks' and the motor switches 'off' is higher in one direction of rotation than the other.

According to the present invention, there is provided a power tool having a motor, a tool holder, and a torque sensitive clutch between the motor and the tool holder, the torque sensitive clutch comprising a driving clutch member and a driven clutch member rotatable relative to one another when the torque transmitted across the clutch exceeds a predetermined value (which may be the same or different in opposite directions of rotation) and means for switching off the motor only when the driving clutch member is being rotated in one and not the other direction and the torque exceeds said predetermined value.

Other preferred features of the invention are set forth in claims 2—10.

In one direction of rotation the motor will be switched off when the torque exceeds said predetermined value. In the other direction of rotation the clutch will ratchet but not switch off when the torque exceeds said predetermined value. In a preferred embodiment the tool is used to tighten and undo fasteners e.g. screws or nuts. In this case, the one direction of rotation of the motor can be used to tighten the fasteners to a predetermined torque and the other direction of rotation can be used to undo them without fear of motor stall.

The invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a longitudinal section through one embodiment of a torque sensitive clutch and switching arrangement of a power tool constructed in accordance with the invention, and

Figure 2 is a section taken along the line A—A of Figure 1 on an enlarged scale.

Figures 3*a* and 3*b* show detailed cross-sections of the clutch engaged and 'broken' respectively.

Figure 4 is a view from the left hand end of the timing ring of Figure 1.

Figure 5 is a side view of the timing ring of Figure 1, and

Figure 6 is a right hand end view of the timing ring of Figure 1.

Referring to the drawings, the torque sensitive clutch shown therein is part of a power tool e.g. a power screwdriver and comprises a clutch driving member 10 and a clutch driven member 12. The driving member 10 is splined to a spindle 14 which is driven by a motor (not shown) *via* a gear box (not shown). The driven member 12 is mounted on the driving member 10 with a ball race 16 interposed therebetween. The driven member has dog teeth 18 at its forward end for driving a tool holder (not shown) and three radial passages 20 at its other end each accommodating a clutch ball 22. The driving clutch member 10 includes three interconnected camming surfaces 24 defined by a cylindrical surface having therein substantially semi-cylindrical recesses 28 each of which locates a roller 30. Each camming surface extends between two radial planes through the driving clutch member which respectively bisect two adjacent rollers 30. The clutch balls 22 are biased radially inwards by a frusto-conical surface 32 on a spring loaded sleeve 34 to contact cylindrical surface portions 26 of respective camming surfaces 24.

The camming surfaces could, however, be defined by faces of a substantially regular polygonal boss portion of the driving clutch member which faces may each be provided with an ear or a detent recess at one edge to provide that the clutch "breaks" at different torque values in opposite directions of rotation.

The frusto-conical surface 32 on the sleeve 34 leads at its larger diameter end to a cylindrical surface 36 *via* a radially outwardly extending step 38 (see in particular Figures 3*a* and 3*b*). As shown in Figure 3*a*, the balls are held in contact with the cylindrical surface portions 26 of their respective camming surfaces by a portion of the frusto-conical surface 32 closely adjacent to the radial step 38 so that only slight radially outward movement of the balls is required to overcome the spring loading on the sleeve 34 and allow the balls to move into contact with the cylindrical surface 36 and the rollers 30 to pass 'under' the balls 22.

The sleeve 34 is axially slidable on the driving clutch member 10 and is loaded by compression spring 40 mounted on the driving clutch member between a thrust washer 42 carried by the sleeve 34 and a lock washer 44 keyed to the driving clutch member 10. The pre-compression of the spring can be adjusted by moving the lock washer 44 along the driving clutch member with an adjusting nut 46, to adjust the breaking torque of the clutch.

A timing ring 48 is interposed between the sleeve 34 and the driving clutch member 10. The timing ring has, in that end remote from the driven clutch member 12, two diametrically opposite grooves 50, 52 (see Figures 5 and 6) which are inclined to a plane normal to the axis of the ring. However, the grooves could be replaced by closed inclined slots or recesses. A transverse pin 54 extends across the timing ring and is located at its two ends in the two grooves 50, 52 respectively. Intermediate its ends the pin 54 extends through elongate slots 56 in the driving clutch member 10 to fix the pin for rotation with th driving clutch member 10 but to allow the pin to move axially in the slots relative to the driving clutch member 10. The other end of the timing ring 48 has projecting therefrom three equi-angularly spaced lugs 58 (see Figures 4 and 5). These lugs engage with the

clutch balls 22 when the driving and driven clutch members rotate relative to one another as described hereinafter, to shift the ring 48 axially away from the driven clutch member 12 for switching the motor on or off.

A push rod 60 extends through the spindle 14 into the driving clutch member 10 where it is releasably held by a latch mechanism 62. The latch mechanism comprises a latch collar 64 fixed to the driving clutch member 10 and an axially movable latch sleeve 66 having radially extending passages 68 accommodating latch balls 70. The latch sleeve 68 is urged to the left as shown in Figure 1 by a compression spring 72 and the inner wall of the collar 64 is tapered inwardly from its right hand towards its left hand end. As shown in Figure 1 the push rod 60 is gripped by the balls 70 urged radially inwards by the collar 64 and when the driving clutch member 10 is moved rearwardly (i.e. to the right as shown in Figure 1) relative to the spindle 14 by applying axial pressure to the tool in the tool holder the push rod 60 will switch on the motor either by operating a switch if the motor is electrically operated or by opening a valve if the motor is pneumatically operated. When the motor is rotating in one direction (usually clockwise) the ends of the transverse pin 54 will occupy the shallower ends of the grooves 50, 52 and when the motor is rotating in the other direction the ends of the transverse pin 54 will occupy the deeper ends of the grooves 50, 52.

When the clutch is engaged, drive is transmitted from the driving clutch member 10 *via* the rollers 30 and the balls 22 to the driven clutch member 12. As the torque increases the balls are forced outwards. This outward movement is opposed by an inward force provided by the sleeve 34.

The sleeve 34 contacts the balls at a position indicated by the broken lines in Figure 2. Outward movement of the balls when the torque transmitted across the clutch reaches a predetermined value causes the sleeve 34 to move longitudinally along the axis of the driving member 10 against the action of the spring 40.

Figure 3*a* shows the position before any movement has occurred, and Figure 3*b* shows the position just as rollers 30 pass 'under' balls 22.

An important feature of this clutch arrangement is that there is a rapid torque fall off once the clutch members 10 and 12 have started their relative rotation. The clutch therefore has a 'snap' action.

When the clutch 'breaks' with the motor rotating in said one direction, the timing ring 48 will be shifted rearwardly due to engagement of the lugs 58 with the clutch balls 22 and the transverse pin 54 will engage the latch sleeve 68 and move it to the right. The latch balls 70 will release their grip on the push rod 60 freeing the latter to move forwardly under spring, air or other pressure. The motor will switch off. To switch the motor on again, the operator must first release the axial pressure applied to the tool to allow the latching mechanism to reset.

When the clutch 'breaks' with the motor rotating in said other direction, the timing ring 48 will be shifted to the right as before but the transverse pin 54 will not engage the latch sleeve 68 because the ends of the pin 54 will be occupying the deeper ends of the grooves 52, 54 (as hereinbefore described). Hence, the motor will not switch off and the clutch will continue to ratchet, until the torque drops below said predetermined value.

The design of the timing ring 48 ensures that the latching mechanism cannot remain in a disengaged configuration (with the latch sleeve in a rearward position).

This is achieved in two distinct methods, either of which would be effective singly, but are both used in this particular embodiment.

The first method is to ensure that the lugs 58 on the timing ring pass over the balls at the same time as the torque transmitting elements (balls 22 and rollers 30) are in an unstable configuration. This ensures that the clutch cannot come to rest with the timing ring in the rearward position.

Such unstable configurations occur twice each time a ball passes a roller, i.e. for each clutch 'break'. Each configuration is spread over a range of relative angular displacement of the driving member 10 and the driven member 12. The first begins as soon as a ball has been displaced outwards by a roller, and continues until the roller approaches the mid-point of its passage past the ball. In this region frictional forces cause an area of stability. As the roller passes this region, the second area of instability begins, and continues until the ball is once again in contact with the next cylindrical surface portion 26.

Either of the two unstable configurations could be used but in the preferred embodiment the latter is used.

The second method is to ensure that the gradient of the bottom of each groove 50, 52 in the timing ring is sufficiently large so that a force can only be exerted on the pin by the timing ring when the pin is being pulled round by the driving clutch member 10. Once the driving clutch member has stopped, the timing ring will be free to move angularly, and to assume a position, in which the transverse pin 54 is no longer at the shallow ends of the grooves in the timing ring.

The major advantage of the above tool is that the shut-off mechanism is unidirectional in operation. This means that the tool will operate as a ratchet type when in for example reverse, enabling fasteners to be undone more efficiently and without fear of stalling.

Moreover, the 'snap' action of the clutch gives rise to greater operator comfort, and improved consistency of torque output.

The major wearing point of any clutch is the point of contact of those elements which transmit the torque and move in relation to one another. In this case these elements are balls and rollers. These balls and rollers are free to rotate, and hence the wear is spread over the entire surface of each ball, and around a line of contact around

each roller. This provides the clutch with a longer life than would otherwise be the case. Additionally these balls and rollers are inexpensive and easy to replace.

CLAIMS

1. A power tool having a motor, a tool holder, and a torque sensitive clutch between the motor and the tool holder, the torque sensitive clutch comprising a driving clutch member and a driven clutch member rotatable relative to one another when the torque transmitted across the clutch exceeds a predetermined value (which may be the same or different in opposite directions of rotation) and means for switching off the motor only when the driving clutch member is being rotated in one and not the other direction and the torque exceeds said predetermined value.

2. The power tool of claim 1, wherein the switching means includes a timing ring fixed for rotation with the driving or driven clutch member and movable axially when said torque exceeds said predetermined value, and a transverse member extending diametrically or substantially diametrically across the ring, the transverse member being capable of limited angular movement relative to the ring between a first position which it will occupy when the driving clutch member is rotating in one direction of rotation and in which it will switch off the motor when the torque exceeds said predetermined value and a second position which is axially as well as angularly displaced from its first position and which it will occupy when the driving clutch member is rotating in the other direction of rotation and in which it will not switch off the motor when the torque exceeds said predetermined value.

3. The power tool of claim 2, wherein at least one end of the transverse member is located in a groove (or slot or recess) in the ring and inclined to a plane normal to the axis of the ring, the arrangement being such that the at least one end of the transverse member will occupy a first or second end of the groove (or slot or recess) depending upon the direction of rotation of the driving clutch member.

4. The power tool of claim 2 or claim 3, wherein the switching means also includes a push rod movable between a first position and a second position and a latch mechanism for holding the push rod in said first position, the latch mechanism being releasable by the transverse member when the driving clutch member is rotating in said one direction only and the torque exceeds said predetermined value, to allow the push rod to move to its second position and switch the motor off.

5. The power tool of any one of the preceding claims, wherein one of the clutch members includes a series of interconnected camming surfaces and the other clutch member includes a series of clutch balls arranged in radial passages around the axis of the clutch, each ball being biased against a respective camming surface by a spring loaded member.

6. The power tool of claim 5 when dependent on any one of claims 2—4, wherein the timing ring is fixed for rotation with the one clutch member (i.e. the clutch member including the series of interconnected camming surfaces) and has at least one projection engageable by one of the balls, when the driving and driven clutch members rotate relative to one another, to move the ring axially.

7. The power tool of claim 5 or claim 6, wherein the spring-loaded member has a frusto-conical surface leading at its larger diameter end to a cylindrical surface *via* a step extending radially away from the camming surfaces, the arrangement being such that when a torque below said predetermined value is transmitted across the clutch the frusto-conical surface of the spring loaded member engages the clutch balls to keep the clutch engaged and when a torque above said predetermined value is transmitted across the clutch the spring loaded member moves axially to allow the balls to move into contact with the cylindrical surface of the spring loaded member so that the driving clutch member can rotate relative to the driven clutch member.

8. The power tool of claim 7, wherein the interconnected camming surfaces are defined by a cylindrical surface having therein angularly spaced apart cylindrical recesses each of which locates a roller.

9. The power tool of any one of claims 5—8, wherein the driving clutch member includes the series of interconnected camming surfaces and the driven clutch member includes the clutch balls.

10. The power tool of any one of claims 5—9, wherein the spring loaded member is loaded by a compression spring and means are provided to vary its pre-compression.

11. A power tool substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

New claims or amendments to claims filed on 20 June 1983

Superseded claims 1—11

New or amended claims:—

1. A power tool having a motor, switch actuating means for switching the motor off, a tool holder, a torque sensitive clutch between the motor and the tool holder, the torque sensitive clutch comprising a driving clutch member and a driven clutch member rotatable relative to one another when the torque transmitted across the clutch exceeds a predetermined value (which may be the same or different in opposite directions of rotation) and means for operating the switch actuating means to switch the motor off only when the driving clutch member is being rotated in one and not the other direction and the torque exceeds a predetermined value, the means for operating the switch actuating means including a part which attains a different axial position relative

to the switch actuating means in one direction of rotation of the driving clutch member than the other when the torque exceeds said predetermined value.

2. The power tool of claim 1, wherein the means for operating the switch actuating means also includes a ring fixed for rotation with the driving or driven clutch member and movable axially when said torque exceeds said predetermined value, and wherein said part is a transverse member extending diametrically or substantially diametrically across the ring, the transverse member being capable of limited angular movement relative to the ring between a first position which it will occupy when the driving clutch member is rotating in one direction of rotation and in which it will operate the switch actuating means to switch off the motor when the torque exceeds said predetermined value and a second position which is axially as well as angularly displaced from its first position and which it will occupy when the driving clutch member is rotating in the other direction of rotation and in which it will not operate the switch actuating means to switch off the motor when the torque exceeds said predetermined value.

3. The power tool of claim 2, wherein at least one end of the transverse member is located in a groove (or slot or recess) in the ring and inclined to a plane normal to the axis of the ring, the arrangement being such that the at least one end of the transverse member will occupy a first or second end of the groove (or slot or recess) depending upon the direction of rotation of the driving clutch member.

4. The power tool of any one of claims 1—3, wherein the switch actuating means includes a push rod movable between a first position and a second position and a latch mechanism for holding the push rod in said first position, the latch mechanism being releasable by said part when the driving clutch member is rotating in said one direction only and the torque exceeds said predetermined value, to allow the push rod to move to its second position and switch the motor off.

5. The power tool of any one of the preceding claims, wherein one of the clutch members includes a series of interconnected camming surfaces and the other clutch member includes a series of clutch balls arranged in radial passages around the axis of the clutch, each ball being biased against a respective camming surface by a spring loaded member.

6. The power tool of claim 5 when dependent on any one of claims 2—4, wherein the ring is fixed for rotation with the one clutch member (i.e. the clutch member including the series of interconnected camming surfaces) and has at least one projection engageable by one of the balls, when the driving and driven clutch members rotate relative to one another, to move the ring axially.

7. The power tool of claim 5 or claim 6, wherein the spring-loaded member has a frusto-conical surface leading at its larger diameter end to a cylindrical surface *via* a step extending radially away from the camming surfaces, the arrangement being such that when a torque below said predetermined value is transmitted across the clutch the frusto-conical surface of the spring loaded member engages the clutch balls to keep the clutch engaged and when a torque above said predetermined value is transmitted across the clutch the spring loaded member moves out of contact with the frusto-conical surface so that the driving clutch member can rotate relative to the driven clutch member.

8. The power tool of claim 7, wherein the interconnected camming surfaces are defined by a cylindrical surface having therein angularly spaced apart part cylindrical recesses each of which locates a roller.

9. The power tool of any one of claims 5—8, wherein the driving clutch member includes the series of interconnected camming surfaces and the driven clutch member includes the clutch balls.

10. The power tool of any one of claims 5—9, wherein the spring loaded member is loaded by a compression spring and means are provided to vary its pre-compression.

11. A power tool substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

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